application in condition for allowance at the time of the next Official Action. Note that the concentration is per cubic centimeter, not per cubic meter.

Claims 1-13, 17-33, and 35-39 were previously pending in the present application. Claims 2-3, 12, and 23-24 are cancelled without prejudice. Therefore, claims 1, 4-11, 13, 17-22, 25-33, and 35-39 are presented for consideration.

Consideration of all pending claims is respectfully requested. Claim 1 is generic to the species of Figures 2-4 and is believed to be allowable. Claim 1 does not require either a masked or a mask-less substrate and thus the embodiments of claims 14-16, 34, and 40-55 are directed to a species of generic claim 1.

Claims 1-7, 11, 13, 17-26, 33, and 35-39 were rejected as anticipated by SUGIURA et al. 6,015,979 and claims 8-10, 12, and 27-32 were rejected as unpatentable over SUGIURA et al. Reconsideration and withdrawal of the rejections are respectfully requested.

Amended claim 1 defines an embodiment in which the active layer has both high and low dislocation density regions, a current injection region, and an impurity concentration of less than 1E18 cm-3, wherein a dislocation density of the low dislocation density region is not more than one tenth of a dislocation density of the high dislocation density region, or wherein the dislocation density of the low dislocation density

region is not more than one tenth of an averaged dislocation density of the active layer.

SUGIURA et al. do not disclose an active layer with both high and low dislocation density regions, and also do not disclose any particular relationship in dislocation density between the low dislocation density region and the high dislocation density region and also any particular relationship in averaged dislocation density between the low dislocation density region and the active layer. The reference does not disclose all the claimed elements and the claims avoid the rejection under §102.

SUGIURA et al. disclose an embodiment in Figure 12 that has a <u>uniform</u> dislocation density. The threading dislocations shown in Figure 12 are representative of the threading dislocations that have a density of about 1E5 cm3 (column 21, lines 20-21). There is no indication that the density of the threading dislocations varies in the active layer 108 or a suggestion that the particular range of the difference in the density or the averaged density between the low dislocation density region and the high dislocation density region or between the low dislocation density region and the active region.

Indeed, SUGIURA et al. disclose that the density of dislocation is "approximately constant" (column 15, lines 20-21). Note that SUGIURA et al. specifically point out when the dislocation density does vary, as in the GaN layer 103 discussed

at column 20, lines 49-53. The failure to mention such variability in the particular range in the multi-layer film, which includes the active layer, and the mention of only one density value would clearly indicate to one of skill in the art that the dislocation density does not vary in the active layer.

Accordingly, one of skill in the art would not find any reason, suggestion, motivation, or teaching to vary the dislocation density in the active layer and this would not find the subject matter of the claims obvious.

Amended independent claim 22 has the same limitations and is allowable for the same reasons as amended claim 1.

Dependent claims 4-11, 13, 17-21, 25-33, and 35-39 further define the present invention. Those dependent claims are, therefore, believed to be patentable over SUGIURA et al. because the amended independent claims 1 and 22 are patentable over SUGIURA et al. for the above reasons.

In view of the foregoing remarks, it is believed that the present application is in condition for allowance. Reconsideration and allowance are respectfully requested.

Attached hereto is a marked-up version of the changes made to the abstract, specification and claims. The attached page is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE."

Respectfully submitted,

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November 4, 2002

VERSION WITH MARKINGS TO SHOW CHANGES MADE

ABSTRACT OF THE DISCLOSURE

The Abstract of the Disclosure has been amended as follows:

[The first present invention provides a] A nitride based semiconductor photo-luminescent device [having] has an active layer having a quantum well structure [the]. The active layer [having] has both [at least] a high dislocation density region and [at least] a low dislocation density region that is lower in dislocation density than the high dislocation density region, wherein the low dislocation density region includes a current injection region into which a current is injected, and the active layer is less than 1 x 10^{18} [m^{-3}]cm^{-3} in impurity concentration.

IN THE SPECIFICATION:

Page 8, the paragraph, beginning on line 11, has been amended as follows:

--The technique for doping silicon into the active layer has been used for improving the laser device performances such as the threshold current density. In Japanese laid-open patent publication No. 10-12969, it is disclosed that silicon impurity is doped into the active layer at an impurity concentration n the range of 1 x 10^{18} [m^{-3}] cm^{-3} to 1 x 10^{21} [m^{-3}] cm^{-3} for improvement in the laser threshold value.--.

Page 10, the paragraph, beginning on line 1, has been amended as follows:

--The present invention provides a nitride based semiconductor photo-luminescent device having an active layer having a quantum well structure, the active layer having both at least a high dislocation density region and at least a low dislocation density region lower in dislocation density than the high dislocation density region, wherein the low dislocation density region includes a current injection region into which a current is injected, and the active layer is less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ in impurity concentration.--.

Page 11, the paragraph, beginning on line 6, has been amended as follows:

--The present invention found out the extremely important and unexpectable facts that if the active layer [is undoped] of the nitride based semiconductor laser device formed over the facet-initiated epitaxial lateral overgrowth gallium nitride substrate <u>is undoped</u>, then a low threshold value is obtained and a longer life-time is also obtained.--.

Page 11, the paragraph, beginning on line 24, bridging pages 11 and 12, has been amended as follows:

--The first semiconductor photo-luminescent device is formed over the facet-initiated epitaxial lateral overgrowth substrate and has the Si-undoped quantum well active layer. The second semiconductor photo-luminescent device is formed over the

facet-initiated epitaxial lateral overgrowth substrate and has the Si-doped quantum well active layer having a low Si-impurity concentration of 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$. The third semiconductor photo-luminescent device is formed over the facet-initiated epitaxial lateral overgrowth substrate and has the Si-doped quantum well active layer having a high Si-impurity concentration of 5 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$. The fourth semiconductor photo-luminescent device is formed over the epitaxial lateral overgrowth substrate and has the Si-undoped quantum well active layer. The fifth semiconductor photo-luminescent device is formed over the epitaxial lateral overgrowth substrate and has the Si-doped quantum well active layer having a low Si-impurity concentration of 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$. The sixth semiconductor photo-luminescent device is formed over the epitaxial lateral overgrowth substrate and has the Si-doped quantum well active layer having a high Si-impurity concentration of 5 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--.

Page 14, lines 3 and 4 have been amended as follows:

--The second device: facet-initiated epitaxial lateral overgrowth; and

Si-doped quantum well active layer of 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--;

lines 5 and 6 have been amended as follows:

--The third device: facet-initiated epitaxial lateral overgrowth; and

Si-doped quantum well active layer of 5 x 10^{18} [m^{-3}]

$\underline{cm^{-3}}$.--;

lines 9 and 10 have been amended as follows:

--The fifth device: epitaxial lateral overgrowth; and Si-doped quantum well active layer of 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--;

lines 11 and 12 have been amended as follows:

--The sixth device: epitaxial lateral overgrowth; and Si-doped quantum well active layer of 5 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--;

the paragraph, beginning on line 14, bridging pages 14 and 15, has been amended as follows:

--There is no large different in the initial threshold current density in the first to sixth nitride-based semiconductor laser emitting devices. In the first and second nitride-based semiconductor laser emitting devices grown over the facet-initiated epitaxial lateral overgrowth substrates and having the Si-undoped active layer and the Si-doped active layer of 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$, the initial threshold current densities are slightly lower than the remaining initial threshold current densities of the third to sixth nitride-based semiconductor laser emitting devices, even the Si-impurity concentrations are lower than 1 x 10^{19} [m^{-3}] $\underline{cm^{-3}}$. This means that the initial threshold current density has no large dependency upon the Si-impurity concentration. In the first to third nitride-based semiconductor laser emitting devices grown over the facet-initiated epitaxial

lateral overgrowth substrates, the first nitride-based semiconductor laser emitting device has the lowest initial threshold current density, and the second nitride-based semiconductor laser emitting device has the second lowest initial threshold current density. If the nitride-based semiconductor laser emitting devices are grown over the facet-initiated epitaxial lateral overgrowth substrates, then the Si-undoped active layer obtains the lowest initial threshold current density. Further, the first to third nitride-based semiconductor laser emitting devices grown over the facet-initiated epitaxial lateral overgrowth substrates are free from any deterioration in performance. The fourth and fifth nitride-based semiconductor laser emitting devices grown over the epitaxial lateral overgrowth substrates and having the Si-undoped active layer and the Si-doped active layer of 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ are also free from any deterioration in performance. Only the sixth nitride-based semiconductor laser emitting device grown over the epitaxial lateral overgrowth substrate and having the Si-doped active layer of 5 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ shows a slight deterioration, for example, a slight voltage raise.--.

Page 18, the paragraph, beginning on line 9, has been amended as follows:

--The dislocation core causes the non-photo-luminescent recombination of carriers. In order to suppress the non-photo-luminescent recombination of carriers, it is effective to

increase the impurity concentration of the active layer to shorten the carrier diffusion length thereby suppressing carriers from flowing into the dislocation cores. It has been known that if the impurity concentration is not less than 1×10^{19} [m^{-3}] $\underline{cm^{-3}}$, then Auger re-combination as the non-photo-luminescent re-combination of carriers frequently appears.--;

the paragraph, beginning on line 24, bridging pages 18 and 19, has been amended as follows:

--If the active layer comprises a single layered structure of a thickness of not less than 10 nanometers in place of the quantum well structure, the reduction of the Si-impurity concentration into less than 1×10^{18} [m^{-3}] $\underline{cm^{-3}}$ provides a smaller effect for improving the life-time than when the active layer comprises the quantum well structure. If the single layered structure of the active layer has a thickness of less than 10 nanometers, then the quantum effect possessed by the quantum well structure appears, wherein the state density has an abrupt rising edge which increases an optical gain and decreases the threshold current density value, whereby the temperature-dependent characteristics are improved. In this case, the reduction of the S-impurity concentration into less than 1×10^{18} [m^{-3}] $\underline{cm^{-3}}$ provides a remarkable effect of improving the life-time as in case of the quantum well active layer.--.

Page 19, the paragraph, beginning on line 13, has been amended as follows:

--The following is one of the reasons why the effect of improving the life-time is less remarkable if the active layer comprises a thick single layered structure of the thickness of more than 10 nanometers in place of the quantum well structure and if the Si-impurity concentration is less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$. The reduction in the Si-impurity concentration of the thick single layered active layer increases the series resistance, whereby the heat generation is increased. The increase in the heat generation causes that even if the Si-impurity concentration is low, then the dislocations are likely to extend and move.--.

Page 20, the paragraph, beginning on line 8, has been amended as follows:

--The first present invention provides a nitride based semiconductor photo-luminescent device having an active layer having a quantum well structure, the active layer having both at least a high dislocation density region and at least a low dislocation density region lower in dislocation density than the high dislocation density region, wherein the low dislocation density region includes a current injection region into which a current is injected, and the active layer is less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ in impurity concentration.--;

the paragraph, beginning on line 16, has been amended as follows:

--Since the low dislocation density region includes a current injection region into which a current is injected, and

the active layer is less than 1 x 10^{18} [m^{-3}] cm^{-3} in impurity concentration, then the Auger recombination is suppressed and also the extension and move of the high dislocation density region into the current injection region in the low dislocation density region are suppressed, whereby the device life-time under the high temperature and high output conditions is remarkably and greatly improved.--.

Page 21, the paragraph, beginning on line 15, has been amended as follows:

--Since the dislocation density of the current injection region is not more than one tenth of the dislocation density of the high dislocation density region, and further the active layer is less than 1 x 10^{18} [m^{-3}] cm^{-3} in impurity concentration, then the effect is obtained for suppressing the dislocations from the extension and move from the high density dislocation region to the low dislocation density region, particularly into the current injection region.--.

Page 22, the paragraph, beginning on line 22, bridging pages 22 and 23, has been amended as follows:

--Since a higher dislocation density region having a dislocation density of not less than ten times of a dislocation density of the current injection region is present in a peripheral region within a distance of 5 micrometers from the current injection region, and the active layer is less than 1 x 10^{18} [m^{-3}] cm^{-3} in impurity concentration, then the effect is

obtained for suppressing the dislocations from the extension and move from the high density dislocation region to the low dislocation density region, particularly into the current injection region.--

Page 24, the paragraph, beginning on line 7, has been amended as follows:

--It is also preferable that the active layer comprises a multiple quantum well structure comprising alternating laminations of undoped quantum well layers and Si-doped potential barrier layers having an impurity concentration of less than 1 x 10^{18} $[m^{-3}]$ cm^{-3}.--;

the paragraph, beginning on line 11, has been amended as follows:

--It is also preferable that the active layer comprises a multiple quantum well structure comprising alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1 x 10^{18} $[m^{-3}]$ cm^{-3} and undoped potential barrier layers.--;

the paragraph, beginning on line 15, has been amended as follows:

--It is also preferable that the active layer comprises a multiple quantum well structure comprising alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1 x 10^{18} $[m^{-3}]$ cm^{-3} and and Si-doped

potential barrier layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--;

the paragraph, beginning on line 20, bridging pages 24 and 25, has been amended as follows:

--The second present invention provides a nitride based semiconductor photo-luminescent device having an active layer over an epitaxial lateral overgrowth substrate having a dielectric mask pattern with a window region, the active layer having both at least a high dislocation density region positioned over the window region and at least a low dislocation density region positioned over the dielectric mask pattern, and the low dislocation density region being lower in dislocation density than the high dislocation density region, wherein the low dislocation density region includes a current injection region into which a current is injected, and the active layer is less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ in impurity concentration.--.

Page 27, the paragraph, beginning on line 10, has been amended as follows:

--It is also preferable that the active layer comprises a multiple quantum well structure comprising alternating laminations of undoped quantum well layers and Si-doped potential barrier layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--;

the paragraph, beginning on line 14, has been amended as follows:

--It is also preferable that the active layer comprises a multiple quantum well structure comprising alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1×10^{18} [m^{-3}] cm^{-3} and undoped potential barrier layers.--;

the paragraph, beginning on line 18, has been amended as follows:

--It is also preferable that the active layer comprises a multiple quantum well structure comprising alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1×10^{18} [m^{-3}] cm^{-3} and Si-doped potential barrier layers having an impurity concentration of less than 1×10^{18} [m^{-3}] cm^{-3}.--;

the paragraph, beginning on line 23, bridging pages 27 and 28, has been amended as follows:

--The third present invention provides a nitride based semiconductor photo-luminescent device having an active layer over a mask-less epitaxial lateral overgrowth substrate having a stripe-shaped nitride based semiconductor pattern with a window region, the active layer having both at least a high dislocation density region positioned over the stripe-shaped nitride based semiconductor pattern and at least a low dislocation density region positioned over the window region, and the low dislocation density region being lower in dislocation density than the high dislocation density region, wherein the low dislocation density

region includes a current injection region into which a current is injected, and the active layer is less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ in impurity concentration.--.

Page 30, the paragraph, beginning on line 10, has been amended as follows:

--It is also preferable that the active layer comprises a multiple quantum well structure comprising alternating laminations of undoped quantum well layers and Si-doped potential barrier layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--;

the paragraph, beginning on line 14, has been amended as follows:

--It is also preferable that the active layer comprises a multiple quantum well structure comprising alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ and undoped potential barrier layers.--;

the paragraph, beginning on line 18, has been amended as follows:

--It is also preferable that the active layer comprises a multiple quantum well structure comprising alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ and Si-doped potential barrier layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--.

Page 34, the paragraph, beginning on line 20, bridging pages 34 and 35, has been amended as follows:

--As compared to the above first and second types novel devices, third to sixth devices were also prepared. The above first type device has the undoped active region and has the silicon dioxide mask pattern width of 10 micrometers, wherein the quantum well layers and the potential barrier layers are undoped. The above second type device has the undoped active region and has the silicon dioxide mask pattern width of 25 micrometers. The third to sixth types devices have the Si-doped active layers. The third type device has the silicon dioxide mask pattern width of 10 micrometers and the Si-impurity concentration of 1×10^{18} [m^{-3}] $\underline{cm^{-3}}$ for each of the quantum well layers and the potential barrier layers in the active layer. The fourth type device has the silicon dioxide mask pattern width of 25 micrometers and the Si-impurity concentration of 1×10^{18} [m^{-3}] $\underline{cm^{-3}}$ for each of the quantum well layers and the potential barrier layers in the active layer. The fifth type device has the silicon dioxide mask pattern width of 10 micrometers and the Si-impurity concentration of 5×10^{18} [m^{-3}] $\underline{cm^{-3}}$ for each of the quantum well layers and the potential barrier layers in the active layer. The sixth type device has the silicon dioxide mask pattern width of 25 micrometers and the Si-impurity concentration of 5×10^{18} [m^{-3}] $\underline{cm^{-3}}$ for each of the quantum of well layers and the potential barrier layers in the active layer.--.

Page 37, lines 18 through 20, have been amended as follows:

--Third sample: epitaxial lateral overgrowth;

silicon dioxide mask width of 25 micrometers; and

Si-doped active layer of 1 x 10^{18} [m^{-3}] <u>cm^{-3}</u>.;

lines 21 through 23 have been amended as follows:

--Fourth sample: epitaxial lateral overgrowth;

silicon dioxide mask width of 10 micrometers; and

Si-doped active layer of 1 x 10^{18} [m^{-3}] <u>cm^{-3}</u>.--.

Page 37, line 24 and lines 1 and 2 of page 38, have been amended as follows:

--Fifth sample: epitaxial lateral overgrowth;

silicon dioxide mask width of 25 micrometers; and

Si-doped active layer of 5 x 10^{18} [m^{-3}] <u>cm^{-3}</u>.--.

Page 38, lines 3 through 5, have been amended as follows:

--Sixth sample: epitaxial lateral overgrowth;

silicon dioxide mask width of 10 micrometers; and

Si-doped active layer of 5 x 10^{18} [m^{-3}] <u>cm^{-3}</u>.--;

the paragraph, beginning on line 7, has been amended as follows:

--There was no large difference in the initial threshold current density in the above first to sixth samples. The fifth sample having the mask width of 10 micrometers and the

Si-impurity concentration of 5 x 10^{18} [m^{-3}] <u>cm^{-3}</u> for the active layer showed a remarkable deterioration, wherein the laser emission is discontinued before 100 hours operation, whilst the remaining first to fourth and sixth samples showed almost no deteriorations. The fifth sample was observed in dislocation by the transmission electron microscope. It was confirmed that the dislocations in the high dislocation density region extend to the low dislocation density region.--.

Page 39, the paragraph, beginning on line 5, has been amended as follows:

--In accordance with this embodiment, if the high dislocation density region 116 is present within 5 micrometers from the current injection region of the active layer, the low impurity concentration of not more than 1 x 10^{18} [m^{-3}] <u>cm^{-3}</u> of the active layer provides a remarkable effect of suppressing the dislocation motion and extension. If the active layer is undoped or the silicon dioxide mask width is not less than 25 micrometers, then the movement or extension of the dislocation from the high dislocation density region to the low dislocation density region is suppressed, the life-time of the laser device under the high temperature and high output conditions is remarkably and greatly improved.--.

Page 40, the paragraph, beginning on line 9, has been amended as follows:

--The impurity doping into the active layer means the impurity doping into either any one or both of the quantum well layers and the potential barrier layers. Namely, all of the quantum well layers and the potential barrier layers in the active layer are undoped or Si-doped at an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ in order to realize the long-life-time of the device.--;

the paragraph, beginning on line 15, has been amended as follows:

--In place of the multiple quantum well active layer, the single layered InGaN active layer is used for a further comparative examination. If the thickness of the single layered InGaN active layer is not less than 10 nanometers, then the low impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ provides no remarkable effect of improving the life-time as compared to the multiple quantum well active layer. If the thickness of the single layered InGaN active layer is less than 10 nanometers to form a single quantum well layer for causing quantum effects, then the low impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ provides such the remarkable effect of improving the life-time as the multiple quantum well active layer.--.

Page 41, the paragraph, beginning on line 1, has been amended as follows:

--The following is one of the reasons why the effect of improving the life-time is less remarkable if the InGaN active

layer comprises a thick single layered structure of the thickness of more than 10 nanometers in place of the quantum well structure and if the Si-impurity concentration is less than 1×10^{18} [m^{-3}] cm^{-3}. The reduction in the Si-impurity concentration of the thick single layered active layer increases the series resistance, whereby the heat generation is increased. The increase in the heat generation causes that even if the Si-impurity concentration is low, then the dislocations are likely to extend and move.--.

Page 42, the paragraph, beginning on line 8, has been amended as follows:

--In accordance with the novel nitride based semiconductor photo-luminescent device, the active layer has the high dislocation density region and the low dislocation density region which has the current injection layer, and the active layer is less than 1×10^{18} [m^{-3}] cm^{-3} in impurity concentration to suppress the Auger re-combination and also suppress the extension and movement of the dislocations from the high dislocation density region to the current injection region in the low dislocation density region, whereby the life-time of the device under the high temperature and high output conditions is remarkably and greatly improved.--.

Page 47, the paragraph, beginning on line 22, bridging pages 47 and 48, has been amended as follows:

--As compared to the above first and second types novel devices, third to sixth types devices were also prepared. The

above first type device has the undoped active region and has the window region width of 10 micrometers, wherein the quantum well layers and the potential barrier layers are undoped. The above second type device has the undoped active region and has the window region width of 25 micrometers. The third to sixth types devices have the Si-doped active layers. The third type device has the window region width of 10 micrometers and the Si-impurity concentration of 1×10^{18} [m^{-3}] $\underline{cm^{-3}}$ for each of the quantum well layers and the potential barrier layers in the active layer. The fourth type device has the window region width of 25 micrometers and the Si-impurity concentration of 1×10^{18} [m^{-3}] $\underline{cm^{-3}}$ for each of the quantum well layers and the potential barrier layers in the active layer. The fifth type device has the window region width of 10 micrometers and the Si-impurity concentration of 5×10^{18} [m^{-3}] $\underline{cm^{-3}}$ for each of the quantum well layers and the potential barrier layers in the active layer. The sixth type device has the window region width of 25 micrometers and the Si-impurity concentration of 5×10^{18} [m^{-3}] $\underline{cm^{-3}}$ for each of the quantum of well layers and the potential barrier layers in the active layer.--.

Page 50, lines 20 through 23 have been amended as follows:

--Third sample: mask-less epitaxial lateral overgrowth; silicon dioxide mask width of 25 micrometers; and Si-doped active layer of 1×10^{18} [m^{-3}] $\underline{cm^{-3}}$.--;

lines 24 and 25 and line 1 of page 51, have been amended as follows:

--Fourth sample: mask-less epitaxial lateral overgrowth;

silicon dioxide mask width of 10 micrometers; and

Si-doped active layer of x 1 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--.

Page 51, lines 2 through 7, have been amended as follows:

--Fifth sample: mask-less epitaxial lateral overgrowth;

silicon dioxide mask width of 25 micrometers; and

Si-doped active layer of 5 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.

Sixth sample: mask-less epitaxial lateral overgrowth;

Silicon dioxide mask width of 10 micrometers; and

Si-doped active layer of 5 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--;

the paragraph, beginning on line 9, has been amended as follows:

--There was no large difference in the initial threshold current density in the above first to sixth samples. The fifth sample having the mask width of 10 micrometers and the Si-impurity concentration of 5 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ for the active layer showed a remarkable deterioration, wherein the laser emission is discontinued before 100 hours operation, whilst the remaining first to fourth and sixth samples showed almost no deteriorations. The fifth sample was observed in dislocation by the transmission electron microscope. It was confirmed that the

dislocations in the high dislocation density region extend to the low dislocation density region.--.

Page 52, the paragraph, beginning on line 7, has been amended as follows:

--In accordance with this embodiment, if the high dislocation density region 116 is present within 5 micrometers from the current injection region of the active layer, the low impurity concentration of not more than 1×10^{18} [m^{-3}] $\underline{cm^{-3}}$ of the active layer provides a remarkable effect of suppressing the dislocation motion and extension. If the active layer is undoped or the silicon dioxide mask width is not less than 25 micrometers, then the movement or extension of the dislocation from the high dislocation density region to the low dislocation density region is suppressed, the life-time of the laser device under the high temperature and high output conditions is remarkably and greatly improved.--.

Page 53, the paragraph, beginning on line 11, has been amended as follows:

--The impurity doping into the active layer means the impurity doping into either any one or both of the quantum well layers and the potential barrier layers. Namely, all of the quantum well layers and the potential barrier layers in the active layer are undoped or Si-doped at an impurity concentration of less than 1×10^{18} [m^{-3}] $\underline{cm^{-3}}$ in order to realize the long-life-time of the device.--;

the paragraph, beginning on line 17, bridging pages 53 and 54, has been amended as follows:

--In place of the multiple quantum well active layer, the single layered InGaN active layer is used for a further comparative examination. If the thickness of the single layered InGaN active layer is not less than 10 nanometers, then the low impurity concentration of less than 1×10^{18} [m^{-3}] cm^{-3} provides no remarkable effect of improving the life-time as compared to the multiple quantum well active layer. If the thickness of the single layered InGaN active layer is less than 10 nanometers to form a single quantum well layer for causing quantum effects, then the low impurity concentration of less than 1×10^{18} [m^{-3}] cm^{-3} provides such the remarkable effect of improving the life-time as the multiple quantum well active layer.--.

Page 54, the paragraph, beginning on line 3, has been amended as follows:

--The following is one of the reasons why the effect of improving the life-time is less remarkable if the InGaN active layer comprises a thick single layered structure of the thickness of more than 10 nanometers in place of the quantum well structure and if the Si-impurity concentration is less than 1×10^{18} [m^{-3}] cm^{-3}. The reduction in the Si-impurity concentration of the thick single layered active layer increases the series resistance, whereby the heat generation is increased. The increase in the

heat generation causes that even if the Si-impurity concentration is low, then the dislocations are likely to extend and move.--.

Page 55, the paragraph, beginning on line 8, has been amended as follows:

--In accordance with the novel nitride based semiconductor photo-luminescent device, the active layer has the high dislocation density region and the low dislocation density region which has the current injection layer, and the active layer is less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ in impurity concentration to suppress the Auger re-combination and also suppress the extension and movement of the dislocations from the high dislocation density region to the current injection region in the low dislocation density region, whereby the life-time of the device under the high temperature and high output conditions is remarkably and greatly improved.--.

Page 59, the paragraph, beginning on line 16, has been amended as follows:

--As compared to the above first type device, the second and third types devices were also prepared. The above first type device has the undoped active region, wherein the quantum well layers and the potential barrier layers are undoped. The second type device has the Si-doped active region with the Si-impurity concentration of 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ for each of the quantum well layers and the potential barrier layers. The second type device has the Si-doped active region with the Si-impurity

concentration of 5 x 10^{18} [m^{-3}] cm^{-3} for each of the quantum well layers and the potential barrier layers.--.

Page 61, the paragraph, beginning on line 11, has been amended as follows:

--There was no large difference in the initial threshold current density in the above first to third devices. The third type device having the Si-impurity concentration of 5 x 10^{18} [m^{-3}] cm^{-3} for the active layer showed a remarkable deterioration, wherein the laser emission is discontinued before 100 hours operation, whilst the remaining first and second type devivces showed almost no deteriorations. The third type device was observed in dislocation by the transmission electron microscope. It was confirmed that the dislocations in the high dislocation density region extend to the low dislocation density region.--;

the paragraph, beginning on line 20, bridging pages 61 and 62, has been amended as follows:

--Before this exmination, the high dislocation density region of each of the above first to third type devices was distanced by about 3 micrometers from the current injection region of the active layer. After the examination, the high dislocation density region of the third type device only extends to the current injection region of the active layer. After the examination, the high dislocation density region of each of the above first and second type devices remained distanced by about 3

micrometers from the current injection region of the active layer. Namely, the distribution of the dislocation density remained unchanged for the first and second type devices having the undoped barrier layers and the Si-impurity concentration of 5 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--.

Page 62, the paragraph, beginning on line 7, has been amended as follows:

--In accordance with this embodiment, if the high dislocation density region 116 is present within 5 micrometers from the current injection region of the active layer, the low impurity concentration of not more than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ of the active layer provides a remarkable effect of suppressing the dislocation motion and extension. If the active layer is undoped, then the movement or extension of the dislocation from the high dislocation density region to the low dislocation density region is suppressed, the life-time of the laser device under the high temperature and high output conditions is remarkably and greatly improved.--.

Page 63, the paragraph, beginning on line 5, has been amended as follows:

--In accordance with the novel nitride based semiconductor photo-luminescent device, the active layer has the high dislocation density region and the low dislocation density region which has the current injection layer, and the active layer is less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ in impurity concentration to

suppress the Auger re-combination and also suppress the extension and movement of the dislocations from the high dislocation density region to the current injection region in the low dislocation density region, whereby the life-time of the device under the high temperature and high output conditions is remarkably and greatly improved.--.

IN THE CLAIMS:

Claim 1 has been amended as follows:

--1. (amended) A nitride based semiconductor photo-luminescent device having an active layer, said active layer having both at least a high dislocation density region and at least a low dislocation density region lower in dislocation density than said high dislocation density region,

wherein said low dislocation density region includes a current injection region into which a current is injected, and said active layer is less than 1×10^{18} [m^{-3}] cm^{-3} in impurity concentration,

wherein a dislocation density of the low dislocation density region is not more than one tenth of at least one of a dislocation density of the high dislocation density region and an averaged dislocation density of the active layer.--

Claim 11 has been amended as follows:

--11. (amended) The nitride based semiconductor photo-luminescent device as claimed in claim 1, wherein said nitride based semiconductor photo-luminescent device is provided over

dielectric mask patterns provided on a gallium nitride top surface of an epitaxial lateral overgrowth substrate, and said dielectric mask patterns have a mask width of not less than 25 micrometers.--

Claim 19 has been amended as follows:

--19. (amended) The nitride based semiconductor photo-luminescent device as claimed in claim 1, wherein said active layer comprises a multiple quantum well structure comprising alternating laminations of undoped quantum well layers and Si-doped potential barrier layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] cm^{-3}.--

Claim 20 has been amended as follows:

--20. (amended) The nitride based semiconductor photo-luminescent device as claimed in claim 1, wherein said active layer comprises a multiple quantum well structure comprising alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] cm^{-3} and undoped potential barrier layers.--

Claim 21 has been amended as follows:

--21. (amended) The nitride based semiconductor photo-luminescent device as claimed in claim 1, wherein said active layer comprises a multiple quantum well structure comprising alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] cm^{-3} and Si-

doped potential barrier layers having an impurity concentration of less than 1×10^{18} [m^{-3}] cm^{-3}.--

Claim 22 has been amended as follows:

--22. (amended) A nitride based semiconductor photo-luminescent device having an active layer over an epitaxial lateral overgrowth substrate having a dielectric mask pattern with a window region, said active layer having both at least a high dislocation density region positioned over said window region and at least a low dislocation density region positioned over said dielectric mask pattern, and said low dislocation density region being lower in dislocation density than said high dislocation density region,

wherein said low dislocation density region includes a current injection region into which a current is injected, and said active layer is less than 1×10^{18} [m^{-3}] cm^{-3} in impurity concentration, and

wherein a dislocation density of the low dislocation density region is not more than one tenth of at least one of a dislocation density of the high dislocation density region and an averaged dislocation density of the active layer.--

Claim 37 has been amended as follows:

--37. (amended) The nitride based semiconductor photo-luminescent device as claimed in claim 22, wherein said active layer comprises a multiple quantum well structure comprising alternating laminations of undoped quantum well layers and Si-

doped potential barrier layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--

Claim 38 has been amended as follows:

--38. (amended) The nitride based semiconductor photo-luminescent device as claimed in claim 22, wherein said active layer comprises a multiple quantum well structure comprising alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ and undoped potential barrier layers.--

Claim 39 has been amended as follows:

--39. (amended) The nitride based semiconductor photo-luminescent device as claimed in claim 22, wherein said active layer comprises a multiple quantum well structure comprising alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ and Si-doped potential barrier layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--

Claim 40 has been amended as follows:

--40. (amended) A nitride based semiconductor photo-luminescent device having an active layer over a mask-less epitaxial lateral overgrowth substrate having a stripe-shaped nitride based semiconductor pattern with a window region, said active layer having both at least a high dislocation density region positioned over said stripe-shaped nitride based semiconductor pattern and at least a low dislocation density

region positioned over said window region, and said low dislocation density region being lower in dislocation density than said high dislocation density region,

wherein said low dislocation density region includes a current injection region into which a current is injected, and said active layer is less than 1 x 10^{18} [m^{-3}] cm^{-3} in impurity concentration.--

Claim 53 has been amended as follows:

--53. (amended) The nitride based semiconductor photo-luminescent device as claimed in claim 40, wherein said active layer comprises a multiple quantum well structure comprising alternating laminations of undoped quantum well layers and Si-doped potential barrier layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] cm^{-3}.--

Claim 54 has been amended as follows:

--54. (amended) The nitride based semiconductor photo-luminescent device as claimed in claim 40, wherein said active layer comprises a multiple quantum well structure comprising alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] cm^{-3} and undoped potential barrier layers.--

Claim 55 has been amended as follows:

--55. (amended) The nitride based semiconductor photo-luminescent device as claimed in claim 40, wherein said active layer comprises a multiple quantum well structure comprising

alternating laminations of Si-doped quantum well layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$ and Si-doped potential barrier layers having an impurity concentration of less than 1 x 10^{18} [m^{-3}] $\underline{cm^{-3}}$.--